

INTRODUCTION

TURNER-FAIRBANK HIGHWAY RESEARCH CENTER

As the research facility for the Federal Highway Administration, the Turner-Fairbank Highway Research Center (TFHRC) coordinates an ambitious program of innovative research and development, and technology and innovation deployment that addresses the safety, infrastructure, and operational needs of the National Highway System.

This binder contains detailed information about the individual laboratories that are housed at TFHRC. The Lab Clips provide an at-a-glance overview of laboratory activities, and the fact sheets describe each laboratory in more technical detail and include information such as research purpose, resources, current projects, accomplishments, and partnerships.

For the most up-to-date information about research, visit the TFHRC Web site at www.tfhrc.gov. To schedule an onsite tour, e-mail us at TFHRC, tours.

*Research that is essential, indispensable, and
connected to our customers.*

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LAB CLIPS

TURNER-FAIRBANK HIGHWAY RESEARCH CENTER

AERODYNAMICS LABORATORY

Keywords:

Aerodynamic stability, long-span bridges, transportation structures, wind effects, vibrations, fluid mechanics, numerical modeling, structural analysis.

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The Aerodynamics Laboratory is the only wind tunnel facility in the United States dedicated solely to studying the complex interactions between wind and bridges or other highway structures. This laboratory explores wind effects and aerodynamics to ensure the performance and safety of long-span bridges in strong winds and advance our understanding of wind effects on transportation structures. The lab recently completed a study that aids in understanding and retrofitting cable-stay bridges.

Activities

- Conducting wind force measurements on tapered hexagonal cylinders.
- Conducting wind force measurements on a model of the Deer Isle-Sedgwick Suspension Bridge in Maine to study curb grate blockage.
- Setting up instrumentation package for cable vibration tests on the C&D Canal Bridge in Delaware.
- Maintaining instrumentation systems and analyzing data from several field installations.
- Archiving field data, developing several unique databases, and establishing an online technical reference library.

ARENS PHOTOMETRIC AND VISIBILITY LABORATORY

Keywords:

Photometry, colorimetry, retroreflective materials, traffic control devices.

Lab Manager:

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The Arens Photometric and Visibility Laboratory helps researchers evaluate the photometric and colorimetric properties of signing and marking materials, including fluorescent and retroreflective materials. Studies of human-centered systems related to visibility issues are also performed in this laboratory.

Activities

- Recommending photometric and colorimetric specifications for traffic control materials.
- Evaluating proposed changes to transport-related lighting and signaling systems, including automotive headlamps, and new technologies in traffic signals and dynamic message signs.

ASPHALT: BINDER RHEOLOGY LABORATORY

Keywords:

Asphalt pavements, binder, mastic, life-cycle costs, rheology, Superpave.

Lab Manager:

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The Binder Rheology Laboratory studies the flow and deformation of paving materials. Lab activities include Superpave® performance-based binder specification testing, research and development, and advanced rheological research in asphalt, modified asphalt, and mastic (binder and rock dust) binders to improve the durability, longevity, quality, and life-cycle cost of asphalt pavements.

Activities

- Developing an asphalt mastic test to predict pavement performance by comparing the predictions from the binder tests with those from the mastic tests.
- Establishing a procedure that will estimate the rheological properties of aged asphalts and unaged asphalts without using the laboratory aging simulation.
- Establishing the proper procedure for fatigue testing of binders using the dynamic shear rheometer.
- Testing binders for the polymer-modified program currently underway as part of the Accelerated Loading Facility (ALF) activities.
- Characterizing the various chemically modified crumb rubber asphalts developed by the chemistry group.
- Providing rheological data for validating the Laboratory Asphalt Stability Test for modified asphalts currently under evaluation.

ASPHALT: BITUMINOUS MIXTURES LABORATORY

Keywords:

Asphalt pavement mixtures, binder, aggregates, rutting, fatigue, Superpave.

Lab Manager:

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The Bituminous Mixtures Laboratory develops and improves bituminous mixture design technology and performance-based tests, and evaluates aggregates, binders, additives, and new materials. Researchers study asphalt pavement mixtures, consisting of asphalt binder and specially sized stones, to optimize asphalt mixtures for specific highway applications, extend pavement life, improve asphalt pavement performance, reduce vehicle wear-and-tear, and shorten construction delays.

Activities

- Validating Superpave asphalt binder tests and specifications, Superpave mixture tests and performance models, and other laboratory tests used to predict the performance of asphalt mixtures.
- Determining if asphalt binder performance is captured correctly by the Superpave asphalt binder specification developed under the 1987–1993 Strategic Highway Research Program and post-program modifications.
- Evaluating the Simple Performance Test for asphalt mixtures. This test was developed to measure rutting and fatigue cracking resistance.

ASPHALT: PAVEMENT TESTING FACILITY

Keywords:

Pavement materials, traffic loading, controlled loading, accelerated pavement testing.

Lab Manager:

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The Pavement Testing Facility consists of 12 pavement test lanes and 2 ALF machines that simulate traffic loading at controlled loading and pavement temperatures. In only a few months, the ALF machines can evaluate pavement specifications, designs, test procedures, and durability of both new and existing pavement materials by applying wheel loads corresponding to many years of truck traffic. Two machines allow simultaneous testing of two pavement lanes under the same ambient temperature and moisture conditions or at the same pavement materials' age.

Activities

- Testing 12 new full-scale, hot-mix asphalt lanes. The lanes include seven polymer-modified asphalt binders and one unmodified binder in an experiment designed to improve the Superpave binder specification.

ASPHALT: SIMULATION, IMAGING, AND MECHANICS OF ASPHALT PAVEMENTS (SIMAP) LABORATORY

Keywords:

Asphalt pavements, properties, design, construction, performance.

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The SIMAP Laboratory relates the internal structure (such as size, location, and orientation of aggregates and air voids) of asphalt mixes and pavements to their mechanical properties and performance. SIMAP uses a three-pronged approach of imaging, simulation, and micromechanics to provide a complete description and understanding of pavement performance, including the design, construction, and properties of asphalt pavements with long service lives.

Activities

- Analyzing asphalt specimens routinely sent from across the United States.
- Developing indices for measuring various types of aggregate inhomogeneity, air void distribution, and aggregate orientation.

BRIDGE MANAGEMENT INFORMATION SYSTEMS LABORATORY

Keywords:

Climatological data distributions, seismic point-source information and strong-motion data, hydraulic and hydrologic information, geotechnical distributions.

Lab Manager:

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The Bridge Management Information Systems Laboratory identifies and analyzes causes and trends of deficiencies within the Nation's bridge inventory. Tools support sophisticated analytical research on existing disparate data sources through a geographical information system platform combined with relational database management systems software and advanced mathematical and statistical software. Data acquired include the time-series National Bridge Inventory, climatological data distributions, seismic point-source information and strong-motion data, hydraulic and hydrologic information, geotechnical distributions, transportation network coverages, and base political data sets. This synthesis of data and advanced tools is not available at any other facility in the world.

Activities

- Conducting studies to correlate spatial deterioration patterns and bridge deficiencies with environmental variables.
- Assessing life-cycle costs to enhance decision-support models for bridge management systems.

CHEMISTRY RESEARCH FACILITY

Keywords:

Materials science, composition analysis, moisture susceptibility, material chemical analysis.

Lab Manager:

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Researchers at the Chemistry Research Facility advance the understanding of material failures and potential performance enhancements, help develop state-of-the-art characterization tools, and test and foster new materials development. The facility validates Federal Highway Administration (FHWA)-sponsored offsite research and assists industry and State and Government agencies with forensic analyses and unbiased support. There are three main laboratories in this facility. The Chemistry Laboratory synthesizes and characterizes highway materials and evaluates the susceptibility of materials to solar radiation, moisture damage, and the harmful effects of deicing chemicals. The Analytical/Spectroscopy Laboratory analyzes and characterizes coatings, paving materials, and other highway materials subjected to varying conditions. The Material Characterization Laboratory identifies the compositions of highway-related materials and evaluates the morphological properties of polymer-modified asphalt binders subjected to varying conditions.

Activities

- Determining benefits of adding fibers to hot-mix asphalt.
- Investigating the materials science of cementitious materials.
- Creating tools to identify harmful materials in aggregate and asphalt supplies with particular emphasis on the components responsible for pavement moisture susceptibility.
- Investigating the effects of lime on performance.
- Improving understanding of the ignition oven and its usefulness as a quality control tool.
- Evaluating highway materials to determine the materials' susceptibility to moisture damage and understand the harmful effects deicing chemicals.
- Evaluating GSB-88, a cationic emulsion consisting of Gilsonite and plasticizers, which is used for sealing asphalt pavements.

CONCRETE LABORATORIES

Keywords:

Concrete materials, concrete forensics, portland cement concrete, PCC, materials selections.

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Researchers in the Concrete Laboratories evaluate new test methods, conduct concrete materials research, and study concrete forensics. The six Concrete Laboratories are Aggregate and Sample Preparation, Concrete Curing/Maturity, Concrete Durability, Mechanical Properties, Plastic Concrete, and Petrographics.

Activities

- Investigating the properties and performance of portland cement concrete (PCC).
- Evaluating and developing new or improved equipment and procedures for assessing PCC properties and performance.
- Examining practices for PCC materials selection, mixture proportioning, and construction.
- Mixing, casting, and testing PCC test specimens.
- Conducting specialized tests and forensic investigations on PCC to help State Departments of Transportation (DOT) research and troubleshoot problems with existing pavements and structures.

FEDERAL OUTDOOR IMPACT LABORATORY (FOIL)

Keywords:

Crash tests, side-impact crash tests, roadside safety.

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FOIL studies the complex interactions between a motor vehicle, its occupants, and roadside objects during a collision. Researchers test both developmental and existing hardware systems, and use crash tests and finite element analyses to develop new specifications and test procedures aimed at improving road safety. The FOIL also produces test data to validate finite element models of vehicles and roadside safety hardware.

Activities

- Conducting full-scale, frontal and side-impact crash tests using passenger cars and pickup trucks. Researchers use an instrumented rigid pole to determine the crush characteristics of these vehicles.
- Conducting frontal tests of poles and similar structures with a reusable test, or "bogie," vehicle.
- Examining low-speed, frontal impacts into roadside structures such as luminaire supports and mailbox supports by using a pendulum test device.

GEOMETRIC DESIGN LABORATORY

Keywords:

Safety, roadway design, geometric design alternatives.

Lab Manager:

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The Geometric Design Laboratory helps establish the standards and procedures for Interactive Highway Safety Design Model (IHSDM) software development. IHSDM is a suite of tools that help highway planners and designers evaluate the safety of highway geometric design alternatives. It contains six modules: Crash Prediction, Design Consistency, Driver/Vehicle, Intersection Review, Policy Review, and Traffic Analysis.

Activities

- Preparing functional specifications for IHSDM.
- Verifying and validating the modules that will become core IHSDM components.
- Conducting alpha testing of IHSDM software.
- Coordinating beta testing of IHSDM software by potential end-users, which include State DOTs and their consultants.
- Providing technical support to IHSDM users.

GEOTECHNICAL LABORATORY

Keywords:

Bridge foundations, retaining-wall systems, shallow-foundation systems, deep-foundation systems, abutments.

Lab Managers:**Foundations**

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The Geotechnical Laboratory studies the complex interactions between soil and structural elements made of steel, concrete, and timber that are used for bridge foundations and retaining wall systems. Researchers test new materials, designs, and construction methods to determine acceptability and identify opportunities for improvement.

Activities

- Characterizing soil and rock materials for both production requirements and research studies.
- Testing and evaluating shallow- and deep-foundations systems. The laboratory has two outdoor test pits that can be filled with various soils for this purpose.
- Constructing and testing full-scale bridge piers, abutments, and retaining-wall structures at outdoor test sites.

HIGHWAY SAFETY INFORMATION SYSTEM LABORATORY

Keywords:

Roadway design, roadway inventory, roadway and traffic variables, crash data, safety.

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The Highway Safety Information System is a multistate database in which crash, roadway inventory, traffic, driver, vehicle, and other information can be linked into analysis files for a wide range of safety studies. The database contains roadway and traffic information about sites with many crashes, as well as sites with very few or no crashes. This allows researchers to evaluate roadway and traffic variables in relation to crash risk.

Activities

- Validating the IHSDM crash-prediction algorithm.
- Studying the effects of lane reductions and conversions on pedestrian, bicycle, and vehicle crashes.
- Studying the safety effects of narrow lanes and shoulders on freeways.
- Developing new geographical information system safety analysis tools.

HUMAN CENTERED SYSTEMS LABORATORY

Keywords:

Roadway infrastructure, pedestrian behavior, geometric issues, traffic control, operational issues, roadway conditions.

Lab Manager:

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The Human Centered Systems Laboratory analyzes driver and pedestrian behaviors across a broad spectrum of geometric, traffic control, and operational issues to help design safe and efficient roadway infrastructures. Specialized environments in the laboratory help researchers examine driver and pedestrian preferences, gather baseline data, analyze complex roadway issues, and test hypotheses in safe, controlled settings.

Activities

- Evaluating how people perceive various pavement markings.
- Investigating how pedestrians respond to different crosswalk signals.
- Analyzing driver paths and speeds through roundabouts.

HYDRAULICS LABORATORY

Keywords:

Hydraulics, fluid mechanics, bridge scour, systems analysis, urban drainage, numerical modeling.

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Hydraulics Laboratory researchers test highway drainage structures and stream crossings to solve hydraulic and stream stability problems and support operational engineers with design guidance and tools. The laboratory has physical modeling and numerical modeling components that work in tandem; results are extrapolated from one and verified and calibrated by the other. The physical modeling components include a tilting flume and a culvert testing facility. The numerical modeling capability features a three-dimensional sediment transport model that can reproduce scour results that can be extended to field conditions.

Activities

- Testing prefabricated versus cast-in-place culvert inlets and multiple barrel hydraulics.
- Resolving unique or very complex design situations in hydraulic capacity, efficiency, and effectiveness.

FHWA/NHTSA NATIONAL CRASH ANALYSIS CENTER (NCAC)

Keywords:

Crash simulation, roadside hardware design, biomechanics, impact analysis, vehicle rollover analysis.

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NCAC is a cooperative venture of the National Highway Traffic Safety Administration and FHWA for automotive and highway safety research. The facility is unique in its comprehensive ability to analyze roadside hardware designs, simulate crashes, and evaluate occupant injuries through analytical and computer modeling. NCAC maintains a national library of more than two decades of crash-test films and documentation by the National Highway Traffic Safety Administration and FHWA. The center includes two laboratories—Vehicle Digitizing and Reverse Engineering, and High-Performance Parallel Computing.

Activities

- Researching vehicle rollover mitigation and countermeasures.
- Analyzing and designing various security barriers.
- Modeling future standard vehicles to evaluate roadside safety performance.
- Conducting crash tests to improve the accuracy of computer models and to reduce the overall time and cost of new hardware designs.

NONDESTRUCTIVE EVALUATION VALIDATION CENTER

Keywords:

Bridge inspection, nondestructive evaluation, human factors, visual inspection, ultrasonic scanning.

Lab Manager:

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The Nondestructive Evaluation Validation Center develops and tests nondestructive evaluation (NDE) technologies that assess the condition of in-service highway bridges. Researchers evaluate existing technologies and develop new tools to improve the state-of-the-practice for bridge inspection. The center is the only facility in the world dedicated to advancing NDE technologies for highway bridges, and it works closely with State DOTs to identify and solve difficult inspection challenges.

Activities

- Exploring the infrastructure application of radiography, neutron backscatter methods, and computed tomography.
- Testing and developing technologies such as infrared thermography and ground penetrating radar.
- Exploring global bridge deflections, wireless instrumentation, and new stress measurement technologies.
- Testing available technologies for fabrication inspection of steel girders, void detection in post-tensioning ducts, and crack detection.

PAINT AND CORROSION LABORATORY (PCL)

Keywords:

Innovative coatings, durability, environmentally compliant materials, corrosion protection.

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PCL provides technical support to the Office of Infrastructure Research and Development. Using both accelerated laboratory tests and natural outdoor exposure, researchers develop and analyze the effectiveness of test procedures for innovative coatings and evaluate the durability of new coatings systems, especially environmentally compliant materials that protect steel bridges from corrosion. PCL helps State DOTs solve a wide variety of bridge coating problems and recommends appropriate coatings for different environmental conditions.

Activities

- Characterizing paint composition using various wet chemistry methods, scanning electron microscopy/energy dispersive analysis, and other spectroscopic techniques.
- Developing rapid forensic analytical techniques to identify bridge coating type and determine causes of field coating failures.
- Determining toxicities of and disposal options for bridge coatings.

PAVEMENT SURFACE ANALYSIS LABORATORY

Keywords:

Profile, rutting, surface texture, grooves, tining, joints, aggregate separation, faulting, warp, curl.

Lab Manager:

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This laboratory develops software and hardware analysis techniques to identify and quantify pavement surface profile and texture parameters with no pavement contact and minimal disruption to highway traffic. Researchers can infer many things about ride quality, safety, and road durability from these traces and measurements.

Activities

- Resolving issues regarding correlation of mean profile depth and mean texture depth, and the quantifying deviation in texture measurements due to travel path variations.
- Conducting studies to reduce noise generated by the friction of tires on pavement.
- Studying aggregate segregation of asphalt concrete pavements.

SAXTON HIGHWAY ELECTRONICS LABORATORY

Keywords:

Electronic engineering.

Lab Manager:

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The Saxton Highway Electronics Laboratory provides electronic engineering design and support services to the offices of Research, Development, and Technology and other FHWA offices. In addition to repairing and maintaining lab equipment, researchers consult on electronic instrumentation requirements, prepare electronic project specifications, and help design and fabricate electronic systems.

Activities

- Designing and installing sensors and data acquisition systems for highway research vehicles.
- Designing and fabricating unique, precision, state-of-the-art electronic instruments and systems for highway research conducted within other Turner-Fairbank Highway Research Center laboratories.

STRUCTURES LABORATORY

Keywords:

Structural materials, bridge structures, bridge components, bridge design specifications.

Lab Manager:

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The Structures Laboratory is a world-class facility in which full-scale bridges can be erected and tested with the latest technology. The laboratory's primary mission is to conduct experimental studies to determine the behavior of bridge components and full-size bridges. Laboratory researchers evaluate the strength and mechanical properties of structural materials and instruments and perform field evaluations of in-service bridge structures. Data from these studies are used to improve national bridge design specifications and the safety, reliability, and cost-effectiveness of bridge construction in the United States.

Activities

- Developing improved specifications to design and analyze horizontally curved steel bridge structures.
- Evaluating ultra-high-performance concrete bridge girders.
- Developing design rules that allow full use of high-performance steels and improve the efficiency of steel bridge design.

TRAFFIC RESEARCH LABORATORY (TReL)

Keywords:

TReL, Advanced Traffic Management Systems (ATMS), Traffic Software Integrated System, adaptive control systems.

Lab Manager:

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TReL assesses and evaluates the impact of various combinations of advanced technologies, strategies, and policies before they are applied in the field. TReL's advanced hardware and software systems help researchers visualize and simulate traffic engineering scenarios. TReL staff also developed and continues to maintain the Traffic Software Integrated System, a suite of traffic analysis tools that assess the impact of transportation improvements to a network. TReL provides the simulation tools needed to test and evaluate real-time adaptive traffic control systems algorithms under a wide range of geometric and traffic conditions.

Activities

- Applying hardware-in-the-loop concepts, where traffic controllers are physically connected with simulated traffic in real time.
- Developing and evaluating dynamic traffic assignment systems.
- Evaluating and demonstrating adaptive control prototypes.